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ABSTRACT

Girls into Science and Technology (GIST) was an action-research project which took action to improve girls' achievement in science and technology and investigated the reasons for their underachievement. The project followed a cohort of students in eight coeducational comprehensive schools from the time they entered secondary school until they made their option choices at the end of the third year. During this time, project staff worked with teachers to devise and implement strategies to reduce sex stereotyping. Among these strategies were a program of visits by women working in technical fields, posters and worksheets about women's contributions to science, curriculum development to produce female-oriented materials, and career advice linked to option choices in schools. Results indicate that the project was successful in refining the understanding of girls' and boys' attitudes and stereotypes about science and the process of option choices. The specific focus of interventions was the stereotyping of science and technology as masculine, and in this respect the children's attitudes were considerably modified. However, children's option choices were less susceptible to GIST interventions. In addition, some teachers' attitudes altered in the desired direction. (JN)

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Girls into Science and Technology

FINAL REPORT

by

Alison Kelly, Judith Whyte and Barbara Smail

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FINAL REPORT FROM THE GIRLS INTO SCIENCE AND TECHNOLOGY PROJECT TO THE JOINT PANEL ON WOMEN AND UNDER ACHIEVEMENT OF THE EQUAL OPPORTUNITIES COMMISSION AND THE SOCIAL SCIENCE RESEARCH COUNCIL

by

Alison Kelly,
Judith Whyte,
Barbara Smail.

With copies to the Schools Council, Shell UK Ltd and the Department of Industry Education Unit.

May 1984

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Part I: Background

Four times as many boys as girls take CSE Physics and three times as many take O level Physics. At least 95% of entries in all technical subjects are from boys (DES, 1983). This means that girls are disadvantaged in a technological society not only in the search for jobs but also as citizens who need to understand and control their environment.

Girls Into Science and Technology (GIST) was an action-research project concerned to explicate the reason for girls' under-achievement in physical science and technical subjects at school, and simultaneously to explore the feasibility and effectiveness of interventions aimed at improving the situation. Previous research (summarised in Kelly, 1981) had documented the extent to which girls drop out of scientific subjects when these become optional and suggested some possible explanations and strategies for change. GIST hoped to explore and test some of these ideas in practice.

Part I of this report sets the scene and Part II gives a factual summary of the work that was carried out by GIST; Part III describes the outcomes of the project while Part IV summarises and assesses the results. A number of papers describing aspects of the project have already been written and reference is made to these for full descriptions. Not all the results are yet available, and these will appear in later papers. A full length book is also in preparation (32).*

1. Organisation

The GIST Project commenced in September 1979. It was jointly directed by Alison Kelly, a sociology lecturer at Manchester University with a degree in physics, and Judith Whyte, an education lecturer at Manchester Polytechnic who had experience in working with adults on attitude change. Barbara Smail, a chemistry graduate with experience in industry and schoolteaching was recruited as Schools Liaison Officer/Research Fellow for Science. At the same time Vera Ferguson began work as the part-time Project Secretary. In the period September 1981 to August 1983 a grant from the Schools Council enabled the futher appointment of John Catton, a CDT Teacher, to develop the technical craft side of the project. In August 1982 Dolores Donegan became Assistant Project Secretary, initially under the WEEP scheme.

The EOC/SSRC Joint Panel funding lasted for three years only, and Ms Smail, Mrs Ferguson and Ms Donegan were supported from September 1982 to August 1983 by grants from the Department of Industry Unit and Shell

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* Numbers refer to papers from the GIST project, see Bibliography attached.

UK Ltd. These sponsors also provided assistance with other expenses such as travelling, computer coding and writing up. We would like to express our gratitude to all five funding bodies.

The project had offices at the Didsbury campus of Manchester Polytechnic, and computing facilities were provided by Manchester University. We are grateful to both institutions for their moral and financial support.

2. Design of the Project

GIST was designed to follow a cohort of approximately 2,000 children from the time they entered secondary school (aged 11) until they made their option choices at the end of the third year. During this time, the project team co-operated with teachers in the schools to devise and implement intervention strategies designed to alter girls' attitudes to physical science and technical craft subjects and increase their chances of continuing these subjects into fourth and fifth year.

Ten co-educational comprehensive schools in three LEAs in the Greater Manchester area were involved in the project, eight as 'action' and two as 'control' schools. The control schools provided data on pupils' attitudes and choices, but were not asked to attempt any interventions. The schools were not a random sample, but they served a wide variety of catchment areas from inner city to leafy suburb. They varied in size from a total roll of under 700 to almost 2,000. We chose only co-educational comprehensives for two reasons: they cater for the majority of girls of secondary school age in Britain at present; and it appears that the problem of girls' underachievement in science may be most severe in co-educational comprehensive schools (Harding, 1981). Although it would have been interesting to compare other school types, in particular single-sex schools, we felt that this would complicate the research design and that it would be difficult to separate the effects of school type from those of catchment area, size and general 'ethos' without involving a much larger number of schools than was practicable.

The first year of the project was spent recruiting the schools, running workshops with teachers, setting up the VISTA scheme, preparing questionnaires and making contact with interested parties particularly employers. This last activity might seem remote from the immediate concerns of the project, but proved to be important in convincing teachers that it was reasonable to encourage girls to study traditionally masculine subjects.

The cohort of GIST children entered secondary school in September 1980. In the next three years a wide variety of interventions were attempted with these pupils and their teachers (see Part II, below). Some time was also devoted to empirical work on attitudes to science and classroom interactions.

3. Action Research

The GIST Project was described as 'action research'. This is a term which is used in different ways by different people. To us it meant that we were trying to take action to improve a social situation

and simultaneously researching that situation and the effects of our action. Research and action were inter-woven. Thus our attitude questionnaires, which in many ways were a traditional research instrument, also generated action when the results were fed back to the teachers. Similarly our classroom observation was undertaken not simply to monitor the mechanisms by which male dominance is established in classrooms, but also to make teachers aware of those mechanisms and help them to develop counter-strategies. Neither the action nor the research was fully planned at the beginning of the project. Both were allowed to develop as new ideas emerged during the course of our work.

The other major feature of the form of action-research we employed was that it was undertaken in collaboration with the teachers involved in the project. Although the original idea and much of the initial impetus came from the project team, the aim was gradually to pass the initiative to the teachers to develop interventions in their own way. From the outset we believed that interventions would work best where teachers believed in them and for this reason teachers were encouraged to adopt and develop strategies to fit their own particular circumstances. The experimental model of implementing different interventions in different schools so that they could be evaluated comparatively seemed inappropriate to our circumstances and was not attempted.

This form of action research has been labelled 'simultaneous-integrated' (23). The philosophy behind it, and some of the advantages and disadvantages of working in this way have been discussed in several papers from the project (5, 23, 25,32).

Part II: Interventions

A large number of different interventions were attempted in schools and these are described in some detail below. The interventions can be roughly divided into four categories. The largest category is the work that the project team did with teachers (Section 4). We had less direct contact with pupils, although we did organise some events with them (Section 5). However most of the work with pupils was done by their teachers. In addition to their day to day classroom interactions, some teachers arranged special activites related to the GIST project (Section 6). Finally there are the audio-visual materials associated with the project (Section 7). Some of these were not completed in time to be used with the GIST cohort in the action schools, but the schools did collaborate in producing and trialling them, and this in itself is interventionist.

Few, if any of these interventions would have taken place if GIST had not existed. It was hoped that their effect upon the children and ultimately the school would be cumulative and qualitative. The qualitative change we aimed for was not just the sum of specific interventions but a difference in pupils' day-to-day experience of science and technology in the classroom. There was no intention to compare the effectiveness of different interventions since the same qualitative change could be achieved by many different routes.

4. GIST Work with Teachers

The interventions in schools were mainly implemented by the teachers because we felt that if there were to be any lasting changes it was imperative that these should be brought about by people who could continue the work after the project formally ended. We therefore took seriously arguments about the 'hidden curriculum' and teacher expectations. If teachers indicate by their actions - or even their tone of voice - that they are sceptical about the aims of the project or about girls' abilities in science and technology, the pupils will probably pick this up. In this way even the best designed interventions could be rendered worthless. Conversely teachers who make only small and apparently insignificant changes in their behaviour but whose attitudes have altered as they have thought about the problem may convey positive messages to their girl pupils. For these reasons we felt that it was important for the project team to spend time with teachers encouraging them to reflect upon their own attitudes and behaviour.

GIST work with teachers was rendered more difficult by the fact that one of the LEA's in which we were working, containing four action schools, was completely re-organised in September 1982 (as the GIST cohort entered their third year). All teachers had to re-apply for their posts, and most moved to different schools. Many of the teachers with whom we had been involved no longer had contact with 'GIST' pupils, and the teachers who took over were understandably pre-occupied with other problems during their first weeks at new schools.

4.1 Teacher Workshops

Our first approach to action schools is fully described in the earliest GIST publication (4). A preliminary talk in each school introduced both senior staff and the teachers who would be responsible for lower school work to the issue of girls' underachievement in science and technology. We described the background to the problem, and some of the suggested intervention strategies and then left staff to discuss our proposals among themselves; they were to let us know within a week or so whether they wanted to become a 'GIST action school'.

In fact none of the schools where we gave this initial talk turned us down. All agreed to the next stage, a series of three two-hour workshop meetings where science and craft teachers would meet with the GIST team to discuss the problems of getting girls into science and technology and develop their own ideas for intervention strategies suitable for their school. These workshops were the first step in the process of making teachers aware of the part their own attitudes and expectations could play in perpetuating sex stereotyping in pupils' subject choice. In addition to discussing interventions the workshops had two main elements. We provided a good deal of information about sex differences in the classroom and research into the origins of these differences. This was intended to convince teachers that it was a serious educational problem and not one that could be wholly blamed on parents, primary schools, employers or 'society'. We also used a number of games and exercises designed to make teachers conscious of their own sex-stereotypes and the way social roles and expectations operate in their classrooms. These exercises have been described in more detail elsewhere (8, 13), as have the rationale for and reactions to the workshops (4, 8, 13).

At a later stage broader staff meetings were held in action schools with representatives from all departments. The point to be made here was that sex-role stereotyping pervades all aspects of life and that notions such as 'science is for boys' or 'girls can't be engineers' are not exclusively picked up in science and craft departments. By increasing general staff awareness of the 'hidden curriculum' we hoped that a school-wide atmosphere conducive to changing children's sex-typed attitudes and choices might emerge. Science and craft teachers could then expect to receive support for their efforts from staff with other subject backgrounds.

Teachers in the project schools were encouraged to develop their own ideas for interventions to try with their pupils, and to criticize and amend our ideas. During the course of the three years a number of teachers did indeed take the initiative in implementing new strategies (see Section 6). However, in the initial phase it was inevitable that our ideas would be more fully worked out than the teachers', and that they would need to be convinced of our competence before trying anything too innovative. In the first year the two main strategies employed in the schools were attitude testing and the VISTA programme (Sections 4.2 and 5.1 below), both of which were mainly organised and run by the project team.

4.2 Feedback to Schools on Attitude Testing

An extensive programme of attitude and achievement testing was carried out with the GIST cohort in their first term at secondary school. This was both a conventional research study and an intervention in its own right. The research results are discussed in Sections 8 and 9 but the intervention aspects will be described here. The tests covered attitudes to, interest in and previous experience of science and sex stereotypes as well as cognitive and background measures. When the data were analysed we produced a booklet for teachers (3) describing what we had found and suggesting actions which might be taken on the basis of these results. We then visited each school with copies of the booklet and detailed statistics for that school and talked to members of the science and craft departments about their pupils. This statistical yet personal approach seemed to make the information more convincing and relevant than the evidence previously presented in general terms (8). For example we had argued in the initial workshops that boys would have more experience than girls of tinkering activities at home and suggested that schools might provide compensatory experiences for girls. This suggestion had little apparent impact; but when it was repeated in the context of results showing that, for example, 55% of boys but only 22% of girls had 'quite often' used a screwdriver, the teachers seemed to appreciate the need for compensatory experience. Several lunch time 'clubs' for girls were subsequently started (Section 6.1). Much of our curriculum development (Section 4.4) was based on the survey results. For example we suggested that physical science topics could be approached via their links with human biology, so capitalizing on both the pupils' initial interest in this area and the common surplus of lower school biology teachers.

4.3 School Liaison Work in Science

The initial plan was for the project team to hold fortnightly meetings with the staff involved in the eight action schools. This proved impossible since the nature and amount of project work varied considerably throughout the year. Moreover we felt that schools were reluctant to allocate the necessary time for regular meetings. Instead a more flexible plan was adopted and we arranged to attend departmental meetings or to see individual heads of department in the early days of each term to outline the plan of action for that term. Follow-up visits were then planned according to the needs of the work. In the first year these meetings were overtly concerned with the administration of the attitude testing and the organisation of VISTA visits, but we always instigated informal discussions of sex differences and sex typing, so keeping the issue of girls and science in the teachers' minds. Every school was visited at least once a month and when curriculum work was being planned or classroom observation undertaken, visits were much more frequent.

Developing personal relationships with individual staff members was felt to be important in facilitating the adoption of strategies which required time and effort on the part of the teachers. We attempted to build up trust by the frequent visits during the first year, our efficient running of the VISTA programme, and the feeding back to the schools of our initial test results. We performed small services for the schools (such as providing photographs showing the correct way to

handle tools and apparatus, which could be used as safety posters - and incidentally featured girls) and avoided small irritants (such as wearing trousers in schools where this was frowned upon for women staff). This personal relationship provided a basis on which individual teachers were prepared to start to rethink their practice along the lines we suggested.

4.4 Curriculum Development in Science

The results of our attitude survey (3) showed clearly that both girls and boys were interested in human biology and science related to youth culture (e.g. how a record player works). They also showed, and this was confirmed by comments from teachers, that girls are much less interested than boys in traditional topics in physical science, particularly electricity. Moreover it is well known that most if not all science textbooks are biased towards boys in the images they portray and the examples they use to illustrate topics (Samuel, 1981; Walford, 1980).

Action-researchers are an unusual breed of educationalist and we frequently felt that we were perceived primarily as curriculum developers who should be providing teaching materials. Although we did not have the resources to make this a major part of the project, we did undertake some curriculum development work (usually in response to direct requests from schools) to try to produce more 'girl-friendly' materials. The rationale behind this curriculum development is explored elsewhere (21, 30, 32).

By 'girl friendly' science materials, we meant

a) removing any masculine bias in the form of illustrations, language and examples;

b) linking experiments with other types of activity, which girls enjoy, e.g. discussions and creative writing;

c) emphasizing the applications of science to everyday life before introducing difficult ideas, concepts and theories;

d) starting with topics familiar and interesting to girls yet leading to an understanding of all aspects of science.

For example, an electricity unit for second years was devised for one school. The teachers in the school wanted to retain the traditional circuit board experiments, which establish relationships between brightness of bulbs and number of batteries and teach the notion of series and parallel circuits. This "hard core" was sandwiched between an investigation of how cassette tape-recorders and record players work, a piece of creative writing about what a home without electricity would be like and work on fuses, plugs and electrical safety in the home.

In the materials currently in use in the GIST schools, we noticed a tendency to approach topics from the point of view of a teacher who had an overview of the whole field rather than from the children's own interests. For example, we found one booklet on light for twelve to

thirteen year olds which started by discussing its wave nature! Individual learning materials frequently emphasized potential dangers in carrying out experiments, presumably as a warning for the more exuberant pupils (usually boys). Teachers were encouraged to make revisions so that the work started with children's interests and the children's ability to handle dangerous materials and equipment safely was cultivated. These adjustments were quite easy to make in practice. For example, the booklet on light mentioned earlier finished with a section on how eyes work, a topic which our test results had shown interested both girls and boys (3). The order of work was reversed so that finding out how eyes work was used as the stimulus for learning more about light. Possible hazards were dealt with by detailing the positive safety precautions to take rather than the normal listing of many "DO NOTS", which can leave the more timid children wondering if there is anything they dare do. These and other ideas are developed more fully in the Science Sourcebook (30).

Like many other curriculum developers we found that the more closely teachers had been involved in the production of the materials the more likely they were to retain them in use. Units written wholly by us and then trialled in the schools were less well received than units rewritten by the teachers themselves in the light of our comments on existing materials. This meant that minor modifications were more likely to be retained than more innovative ideas. For example the booklet on light, which was rewritten by the teachers so that it began with eyes and moved on to more abstract topics, continued to be used. Eyes were a familiar topic in the syllabus and teachers were convinced of the reason for re-ordering the booklet. But the introduction to electricity via the workings of record players and cassette recorders did not become established, even though it seemed to be popular with the children. This was not part of the normal approach to electricity and teachers felt that it was too complicated to be thoroughly understood. However other parts of the unit, such as the work on fuses, plugs and electrical saftey in the home, were retained. In some schools pieces of creative writing were not seen as proper science and tended to be dropped; but other schools attempted to introduce more such exercises into their teaching. Work cards that were adapted to include more pictures of girls and examples of their interests generally continued to be used.

4.5 Schools Liaison Work in CDT

The addition to the team of John Catton, a former head of a school CDT department, greatly increased our credibility with the all-male staff teaching CDT. He spent a considerable amount of time discussing with them the rationale for encouraging girls into the workshops and how their attitudes could affect behaviour and performance. However the Schools Liaison work in CDT was also concerned with explaining the advantages for both sexes of a move away from the traditional craft courses to a design-based approach in which practical problems are solved in a creative yet logical manner. With the decline in craft apprenticeships and the rapid changes in technology which are currently taking place, a problem-solving approach will undoubtedly prove more useful than a thorough training in skills which may soon be outmoded. This approach may have particular advantages for girls who feel excluded from traditional craft courses with their masculine image and bias

towards engineering apprenticeships. These arguments are explored in more detail in the CDT Sourcebook (31) which also develops some curriculum ideas.

A further problematic issue in CDT was the question of choice. Two schools in the GIST project, one action and one control, were possibly contravening the Sex Discrimination Act by teaching woodwork and metalwork to boys and cookery and needlework to girls in the first three years. Much time and energy were expended in persuading the action school to offer a non-segregated craft curriculum. They finally agreed to do so for the year group following the GIST cohort only (the control school arrived at a similar decision without our persuasion, because of staff losses). All the other schools had some sort of craft 'circus' in the first year, but one segregated the sexes at the end of that year and three others offered mini-options at the end of the second year. Harding and Grant (1983) have shown how these mini-options can effectively foreclose non-traditional choices, and we tried to convince the schools that it was in their pupils' interest to postpone decisions between craft subjects until the end of the third year. Eventually two schools abandoned their mini-options and the one which had divided the pupils by sex changed to an option system.

4.6 Other Schools Liaison Work

One of the problems which arose from appointing Schools Liaison Officers with specific subject designations was a tendency for GIST to become defined as a science/craft curriculum development project. The sources of sex differentiation in subject choice lie not only in the attitudes and practice of Science and CDT departments, where male bias is certainly highlighted, but in the traditional assumptions of the school and social interactions taking place throughout the school day. All but one of the action schools was persuaded of the need for a whole staff meeting at which these concerns were presented and discussed. As a result, some teachers of English, Humanities, Personal and Social Education, etc., asked what they could do to assist the aims of GIST and appropriate materials were produced in response to their request (see Sections 4.9 and 7.4). Organising these meetings and planning related curriculum work frequently entailed contact with senior management, and this, together with arrangements for the teacher conferences (Section 4.8), gave us some insight into the distinct ethos of each school and the attitude, sympathetic or otherwise, of the headteacher towards GIST. Fuller discussion of the significance of individual school features and headteachers' predilections appears in the GIST book (32).

4.7 Classroom Observation

One widely quoted classroom observation study (Spender 1978; 1982) claims that teachers almost inevitably favour boys in class. In the workshop discussions this finding appeared to be one of the most interesting and controversial aspects of research on sex differences. Some of the teachers were already aware of the research and took a fatalistic attitude to it, others disputed it hotly. Our own classroom observation was undertaken to provide staff with some information on the way they and their pupils behaved in class. We hoped that this would clarify for teachers the mechanisms by which boys come to dominate in

the laboratory and workshop and assist them in developing techniques of classroom management to minimize male dominance.

The teachers knew that we were interested in their interactions with girls and boys, so their behaviour in this respect was certainly different from normal because of our presence. However we felt that this was beneficial in that they were practising an egalitarian distribution of their time. If practised frequently enough this should become second nature. At the end of each period of observation we discussed our findings, both quantitative and qualitative, with the teacher so that s/he got immediate feedback on the experience of being observed. The results of the classroom observation are summarised in Section 9.3. They suggest that teachers can achieve numerical equality in their interactions with girls and boys, but that they may need to adopt a more interventionist style of classroom management if they are to prevent male domination. Questions asked of specific individuals rather than the class as a whole prevent boys shouting out (although care must be taken not to ask a boy for the answer if a girl has trouble!). Distribution of apparatus and rotas for the use of equipment are more conducive to sex equality than a first-come first-served system.

We suggested to teachers that they might take over this aspect of the project and observe each other within departments. This happened successfully in two schools, but in others there was an understandable reluctance to spend scarce free periods in this way. Many teachers also seemed to find the idea of being observed by their colleagues quite threatening.

4.8 Teacher Conferences

Two conferences were organized during the course of the project for teachers in the GIST schools. These were intended to keep teachers from different schools in touch with one another and engage them as participants in the GIST innovation. The first conference was held on a Saturday in December 1980 and stressed the importance of technological education for girls; it focussed on links between science and technical crafts departments with an HMI speaker and a teacher who combined elements of science and CDT in his teaching. The second conference was held in school time in March 1982 and focussed on classroom interaction. With a certain amount of persuasion from the GIST team, all schools acknowledged the importance of this conference by permitting teachers to leave school to attend. The aim was to encourage teachers to examine their own practice and become 'teacher-researchers', by presenting examples of work that had already been done in this area.

The conferences were both enjoyable events but the task of creating links between teachers and departments proved difficult. Both science and craft departments have their own territory in schools and are prone to social separation from other members of staff. However some of the heads of science who attended the first conference subsequently become more enthusiastic about GIST. After the second conference more teachers invited us to observe their classrooms and a small number were encouraged to research their own school situation.

4.9 Options and Careers

As the GIST cohort entered their third year at secondary school the project began to concentrate more on the option choices for fourth and fifth year that the children would soon be making. In many cases pupils make these choices with little real thought about their consequences for future career prospects. Conventions and stereotypes abound. We wanted to link the option choice to careers education in a broad sense (i.e. not advice about particular careers but information about a variety of lifestyles and opportunities).

The previous year's option booklets were collected from all action schools and detailed comments made on their content. Comments covered topics such as timetabling which made it difficult to take a mixture of traditional 'girls' and traditional 'boys' subjects together, and language which implied that only one sex took a subject. In fact both these faults were encouragingly rare. We proposed alterations where the description of a subject seemed rather technical and offputting and suggested that links be made between subjects and careers which appealed to both sexes. Many of these alterations have been incorporated into the revised options booklets.

More general comments on Options and Careers were incorporated in a booklet by that name (7) which was distributed to the schools. This contained suggestions on how to help the pupils to think seriously about their option choices and information on women's changing world of work. It also contained Appendix lists of resources for careers and lifestyle education; jobs that require or use scientific or technical qualifications; and non-traditional jobs that might appeal to 'feminine' interests. This has proved one of the most popular and apparently useful of the GIST publications and we hope that one of our sponsors will consider funding its preparation for commercial publication.

4.10 Wider Contacts

As well as working directly with the eight project schools we have spent some time on a wider range of contacts. The project has attracted considerable publicity, including features in two television programmes, several radio broadcasts and numerous newspaper and magazine articles. We have had over 1,000 enquires from individuals, mainly teachers, and our publications and bibliography have been widely distributed. The project team has received more requests to speak than we could possibly handle and although we were forced to turn down many invitations, we did consider publicity to be an important part of our work. Girls' under-achievement in science and technology is closely linked to society's attitude towards women. Publicizing the problem and our work has undoubtedly contributed to changing attitudes and this in turn may feed back to the schools. Moreover media interest can give a boost to teachers' morale within the project schools.

In addition to part-funding the main GIST project the Schools Council provided funds for 'networking' - the building up of a wider range of contacts and initiatives. This enabled us to give a considerable amount of time and assistance to the preparation of the Manchester LEA's guidelines on sex stereotyping in secondary schools. The authority has now begun a programme of in-service training and

appointed co-ordinators for equal opportunities in each of its secondary schools. Other direct spin-offs were our participation in the Shropshire initiative 'FUTURA Girls' (Brown, 1983) in which the LEA offered a week long technology confidence-building experience for 24 girls from Telford schools. The scheme is to run again in 1984, entirely financed by the LEA. In Wolverhampton we assisted a group based at the Polytechnic's Department of Curriculum Innovation which will promote awareness of the part girls have to play in the new technology in schools, set up girls' computer clubs and invite professional women in computing to visit local schools. In Nottingham two curriculum development leaders are starting a scheme similar to GIST, and they have used the GIST film (Section 7.3) in their initial training workshop. In 1984 the network of teacher educators in Britain and Europe will focus on a conference funded by the E.O.C. on ways of promoting 'girl-friendly' schooling in mixed schools.

5. GIST Work with Pupils

For reasons of time, the GIST team did not have much direct contact with pupils. Most of our suggestions were implemented by teachers in our absence. We did meet the pupils occasionally, but even then there was usually a teacher present, and her or his attitude influenced the way in which the children approached the event. These occasions are described below.

5.1 The VISTA Programme

One of the major intervention strategies throughout the GIST project was the VISTA programme, a series of visits to schools by women working in science and technology. The aim of the visits was to provide the children with role models of women working in 'masculine' occupations who enjoyed their work and were successful at it. Ideally they should have an attractive and vivacious personality and be leading active personal and family lives. In this way we hoped to counter the image of the woman scientist as an oddity and reassure the girls that studying science did not mean abandoning all their existing dreams of adult life. We also wanted to de-stereotype the remote impersonal image of science and technology by stressing the links between the work the VISTA visitors were doing and what the children were learning in class (11).

Women were recruited for this programme through letters to the press and contacts with local employers. Volunteers were coached in ways of talking to 11-13 year olds by the GIST team. They often needed some help in picking out bits of their jobs which would appeal to this age group and in simplifying their language to match the children's vocabulary.

Whenever possible visits to schools were arranged so that the woman's work was linked to the topic the children were currently studying. For example when they were learning about acids and alkalis there was a food technologist who brought cakes made from cake mixes with incorrectly balanced baking powder to show the use of pH measurements in the food industry. At first most of the VISTA visitors were graduates, but as the project progressed John Catton made

particular efforts to recruit younger and less highly qualified women (e.g. trainee plumbers and motor mechanics). Children often found it easier to identify with these women, but unfortunately they were less likely than the graduates to have the verbal skills and self-confidence to face a school class on their own. So we tried to arrange that they visited schools in groups and spent more time on practical demonstrations.

VISTA was evaluated by requesting teachers to fill in a report form after each visit; pupils were asked at the end of the project which visits they remembered, how they rated them, and what were the best and worst aspects of these visits. Most teachers thought the VISTA visits were a success. A few of the women used language that was too difficult for the children, but the majority of them avoided this trap and provided an interesting talk. Many teachers commented that the boys were more involved in question and answer sessions than girls; they also remarked that the pupils did not seem to appreciate that the visitors were women doing traditionally male jobs.

The children's evaluation of the visits was also generally favourable with the girls being somewhat more enthusiastic than the boys. Girls in particular said that they appreciated the opportunity to learn about a range of different jobs and to see women in these jobs. During the course of the project children in action schools became less likely than those in control schools to see science as a masculine subject (see Section 8.2). This indicates that the role modelling aspect of the visits was noticed by the children. Both girls and boys said they enjoyed demonstrations and asking questions, but were not so keen on visits where they had to sit and listen; this distinction was echoed in the teachers' comments.

The VISTA programme has been described more fully elsewhere (4, 11). It has now been taken over by the North West SATRO (Science and Technology Regional Organisation) and is continuing to operate although the GIST VISTA has finished. Similar schemes have started in other parts of the country, further evidence of the national impact GIST has had.

5.2 Roadshows: 'Whatever you choose to do, it's OK'

Despite the information in the Options and Careers booklet, many teachers were reluctant to embark on activities designed to question traditional values and lifestyles. However they were usually willing for the project team to undertake such sessions with their classes. Teachers' inhibitions about instigating open discussion of the gender issue is a key point explored more fully in the GIST book (32). As option choice approached we organised a 'Whatever you choose to do it's OK' day in each school. The particular activities involved varied from school to school. Typically there might be a film such as 'Jobs for the Girls', about a girl who wants to be a motor mechanic, with a follow-up discussion; then perhaps a tour of the careers exhibition and finding the answers to a quiz which were all hidden in the display materials. Then the class would meet a group of three or four visitors who had non-traditional jobs. For this we recruited not only women engineers, car mechanics, carpenters, etc., but also male nurses, cookery teachers, men who look after young children and a househusband with career wife.

Finally the pupils were encouraged to explore their own strengths and weaknesses, likes and dislikes in a game organised by their form tutor, so that they could better identify the jobs to which they would be suited. These activities and pupils's reactions to them are discussed in more detail eleswhere (27).

Many boys, and to a lesser extent girls, revealed very traditional and rigid attitudes about the separate roles of women and men in society. Despite their first hand knowledge of working mothers and one parent families we found children often had a stereotyped view of their future life, with the woman as full time homemaker and the husband as full time breadwinner. Nevertheless they appeared to enjoy discussion of alternative views and possibilities. Many children came up at the end of the day to tell us of the non-traditional choices they would like to make. However some boys were uncomfortable with alternative views; as a group they exhibited some hostility to the male visitors, and frequently queried their sexuality (27). Although not specifically asked to comment on the the male visitors in their evaluations of VISTA many pupils did so (perhaps because they were fresh in their minds). It was noticeable that the boys rated the men significantly worse than the girls did, and worse than they rated the women visitors. The implications of boys' greater negativism in this respect are discussed elsewhere (27, 32).

5.3 Option Choice Evenings

Some schools held meetings for third year children and their parents to discuss option choices with staff, and GIST was represented at all the meetings held. The format of the evening varied from school to school. In some, we were able to address the parents as a group, in others only individual consultation was possible. A small dismountable exhibition stand was prepared for these occasions, posing the question "Are these subjects any use to girls?". Posters and photographs showed girls in traditionally masculine occupations requiring physics, chemistry and technical qualifications and the technological nature of future employment was stressed. We also showed the two slide/tape displays "Why Science?" and "Why CDT?" (Section 7.2) during the evenings.

5.4 Exemplary Teaching in CDT

In the one action school where crafts were segregated by sex, John Catton undertook to teach a mixed first year group in the year following the GIST intake to demonstrate some of the approaches which can be effective in mixed classes. He tried to use a design-based rather than a traditional approach in order to offer both sexes the chance to plan, make and test something with a clearly defined function. A vehicle testing project was chosen, in part to challenge the belief of some CDT teachers that girls would only be interested in producing decorative pieces such as jewellery. Much was learned about pupil interactions in the workshop, ways of overcoming girls' reluctance to use unfamiliar machines such as the disc sander or pillar drill, and how to prevent boys from demanding more than their fair share of time and attention. This teaching experience is described more fully elsewhere (10, 31, 32).

6. Teacher Initiated Work with Pupils

As the project progressed teachers began to generate and implement more of their own ideas for interventions. We had always hoped that the project would be collaborative between ourselves and the staff of the schools, so this willingness to take initiatives was a welcome development. It signified an increased identification with the aims of the project which would presumably manifest itself to the pupils in many small ways as well as in the actual innovation.

6.1 Single Sex Classes and Clubs

Girls seem to have better attitudes to, and be more likely to choose, physical science in single sex schools than in mixed schools (Harding, 1981; Ormerod, 1981; Smithers and Collings, 1981). In 1979 a mixed school in the Manchester area, aware of this research and worried about their girls' achievement, introduced single sex classes in maths and science. Initial results were quite positive (Smith, 1980), and several other schools around the country have subsequently tried a similar strategy, with generally favourable outcomes (e.g. Rhydderch, 1982; Wilce, 1983). Single sex grouping was suggested to GIST action schools at the initial workshops. Although it occasioned some interest, no school adopted it at this stage. Some argued that it was against the philosophy of co-education to separate the sexes; others that it was impractical for timetabling reasons.

As the project progressed and teachers became more aware of the underlying rationale for this innovation, they became more sympathetic. Several of the action schools made some effort to run clubs for girls in science or technology; in one, the head of lower school science worked with girls on physical science topics, and with boys on biological topics in single sex lunchtime sessions; later the school introduced single sex science teaching in third year, and the staff involved have monitored the work and may produce an article for publication. In a second school, an all girls' group was entered for the Granada TV Power Game and came second, and in a third a craft club for girls ran for more than two terms (although it consisted of a rather straightforward 'woodwork by numbers' project). However, not all these innovations retained their single sex character. A technology club in a fourth school initially recruited more boys than girls, and considerable effort was needed by the teacher to equalise the numbers. This experience and others are described in the CDT Sourcebook (31). Elsewhere a girls' technology club in one school failed to get off the ground and in another it quickly became mixed.

6.2 Work Experience Course

The idea for an all-girls work experience course in an electronics firm came from one of the teachers who had organised a similar course from his previous single-sex girls' grammar school. Running such a course from a mixed school presented problems under the Equal Opportunities legislation. GIST arranged a meeting with senior staff from two GIST schools to discuss a joint 'positive discrimination' intervention. The legal problems were eventually solved when the Engineering Industries Training Board (EITB) offered to sponsor the

course, but by then it was too late to run it for the GIST cohort before they made their option choices. Eventually twenty third year and twenty fourth year girls attended two day courses in October 1983 (EOC, 1984).

6.3 Day trip to Design Workshop

One action school arranged for third year girls who were studying CDT to visit the Design Workshops at Manchester Polytechnic. They spent a day going round the workshops, talking to the women students, hearing about the work involved and whenever possible trying out the techniques for themselves. The purpose of this visit was to provide the girls with role-models of women near their age who were successful in a traditionally masculine field, and to demonstrate the range of applications of CDT skills. For maximum impact the visit was arranged shortly before the girls made their option choices for fourth and fifth year(28).

6.4 Senior Girls as Role Models

In another school senior girls were used as role models. Two girls doing 'A' level Design were invited by the head of CDT to help him with third year classes. They acted as teaching assistants, showing younger pupils how to use the tools and equipment and incidentally demonstrating that girls could be competent in the workshop.

6.5 Feedback of Marks

The initial GIST survey contained a spatial ability test and mechanical reasoning test. *A priori* arguments suggested that performance on these tests might be relevant to achievement in CDT. One school decided to inform pupils who had done well in the tests of their success, and suggest that they might consider continuing CDT into fourth and fifth years. After considerable debate it was decided that letters should be sent to the parents of both girls and boys who had scored highly, telling them of their children's good performance, and inviting them to contact the head of department if they wanted to know more about CDT. Although both sexes were included in the scheme it was expected to have more effect for girls who might otherwise never consider taking this subject.

6.6 Curriculum Innovation

Some curriculum materials written by the project team at teachers' request and modifications developed by teachers at our suggestion have already been described (see Section 4.4). In addition to using these materials some departments began to introduce their own innovations into their curricula. These were sometimes quite minor, such as substituting elasticated luggage straps for chest expanders as an example of a force. However one school undertook a major revision of their junior science syllabus, rewriting their workbooks to make them more child centred (i.e. based on children's interests rather than the logical development of the subject as adults see it).

6.7 Self-awareness

In two schools teachers associated with GIST worked with pupils to increase their knowledge of themselves and their situation. In the first instance a science teacher taking a personal and social development class used active-tutorial work methods to get the children talking about what went on in science lessons. They quickly became aware of many ways in which girls and boys are treated differently and behave differently. In the second case a science teacher involved in the option choice process asked the pupils to write a report on themselves, describing their own strengths and weaknesses. In both cases the pupils had to think about themselves, and so became more aware of influences on their actions which are usually taken-for-granted.

7. Materials

In addition to the interventions aimed directly at the GIST cohort of pupils, the project also produced or helped to produce, a range of materials which we hope will be used in other situations. Some of these, such as the Science and CDT Sourcebooks (30, 31) and the Option and Careers Booklet (7) have already been mentioned. Others are described below.

7.1 Women Scientists Booklet and Posters

The image of science as a masculine subject is reinforced by the fact that women's achievements in science are largely unknown. To demonstrate to pupils that women have made important contributions to science, GIST produced some worksheets on women scientists suitable for use in the lower secondary school. The worksheets contain information about the women's lives and scientific work with related crosswords, quizzes and puzzles. They have now been incorporated into a booklet (26) illustrated by Kim Barrington, a student on the Design for Learning course at Manchester Polytechnic.

Many school science laboratories display the poster series Great Scientists. The scientists featured in it are all men, with the exception of Marie Curie. The men are all shown alone, but Marie Curie is surrounded by her family. GIST suggested to the Equal Opportunities Commission that similar posters about women scientists would help to counter the masculine image of science. They agreed, and a series of six posters has now been produced. The scientific information was supplied by GIST and the graphics were done by the E.O.C. The posters, attractively produced, are available free of charge from the E.O.C.

7.2 'Why CDT?'

Patterson (1980) has described a tape slide presentation Why Science? which was developed to demonstrate to pupils, particularly girls, the range of jobs for which physical science was a useful qualification. We obtained a copy of this presentation and used it to some effect in the schools. However, nothing similar existed in the Craft Design Technology area, so we decided to produce a similar tape-slide show called Why CDT?. This was accomplished by John Catton, in

conjunction with photography student Susan Reynard.* The slides show the importance of CDT in a range of technical jobs and also stress the point that the interpretation of symbolic information enters into many aspects of life, from putting together self-assembly furniture to getting the best value for money when purchasing electrical equipment. The finished product, with accompanying notes, will be distributed through Schools Council/Drake Distributors Ltd for use in in-service teacher training.

7.3 'Fair Shares' Video -Film

The Manchester Polytechnic School of Film and Television together with GIST have produced a short (16 minute) colour video called Fair Shares intended for use in in-service teacher training. The script was written by GIST and the video illustrates some features of classroom interaction through dramatic reconstructions of incidents we had observed in laboratories and workshops. The video, with accompanying notes, will again be distributed through Schools Council/Drake Distributors Ltd.

7.4 'Gender in our Lives' Workpack

Few materials offering information about non-traditional opportunities and lifestyles to pupils aged 12-14 actually exist. GIST prepared a pack suitable for use in Personal and Social Education (PSE), including some published and some original discussion materials and exercises. For instance in our pilot survey of children's attitudes, a definite stereotype emerged of the female scientist as a brainy hardworking slightly odd woman, rather like a witch, whose experiments often went wrong. A section of Gender in our Lives attempts to lead children into critical questioning of both negative and over-idealised images of women, by examining prejudices which in the past defined some women as 'witches'. The pack was pilotted in three schools, and appeared to be most successful in the context of an existing PSE syllabus, and when taught by sympathetic and interested teachers. The material needs further development, and will probably be passed on to two teacher groups, one for PSE in Manchester, the other a careers education group in Sheffield.

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* Susan Reynard was tragically murdered shortly after completing this project. Why CDT? contains the only published examples of her work and we would like it to be seen as a tribute to her.

Part III: Outcomes

The outcomes of the GIST project can be evaluated under various headings. For many people the most important question is whether we have been successful in altering girls' option choices and attitudes. This is discussed in Section 8. However we were also concerned with the production of knowledge about the process of science education and option choices, and this is covered in Section 9. In addition some of our work has contributed to the understanding of change in schools and teachers (see Section 10). Although in the nature of action research these distinctions are somewhat arbitary they are conceptually convenient and provide a framework for assessing the outcomes of the project.

8. Changes in the Pupils

The GIST project was unusual in aiming to change a situation as well as study it, and in many ways the practical outcomes are the most intriguing. However they are also the most difficult to assess because the world is intrinsically complicated and contradictory. Results are seldom clear cut and even when they are apparently unambiguous it is frequently difficult to argue from cause to effect.

8.1. Option Choices

One of the main aims of the project was to encourage more girls to choose physical science and technical craft subjects when these became optional in fourth and fifth year. However option choices fluctuate from year to year, and one year's choice cannot be interpreted in isolation. Figures 1 to 3 show the percentage of the year group of girls and boys taking physics, chemistry and technical crafts in the GIST cohort and in each of the three preceding years. Each school is shown separately because the wide variation in option choices would render aggregate statistics meaningless.

The message from these option choices is ambiguous. At some of the action schools there were small increases in girls choosing non-traditional subjects, but at others the project seemed to have little impact on subject choices. Figure 1 shows that a higher proportion of girls chose physics in the GIST cohort than in any of the previous three years at four of the action schools (Ashgrove, Edgehill, Moss Green and Tall Trees).* The increases ranged from 13% to 5%. However both the control schools also had a higher proportion of girls taking physics in the GIST cohort than in the previous years! At three other action schools there was little change, while at one (Hamlet) there was a clear drop in the percentage of girls choosing physics. Among boys there was much less variation. Only at Hamlet (where there was again a drop) and the control school Burnbank (with a striking increase) did the GIST cohort deviate from the pattern of previous years. In Chemistry three action schools (Green Park, Moss Green and Tall Trees) and one control

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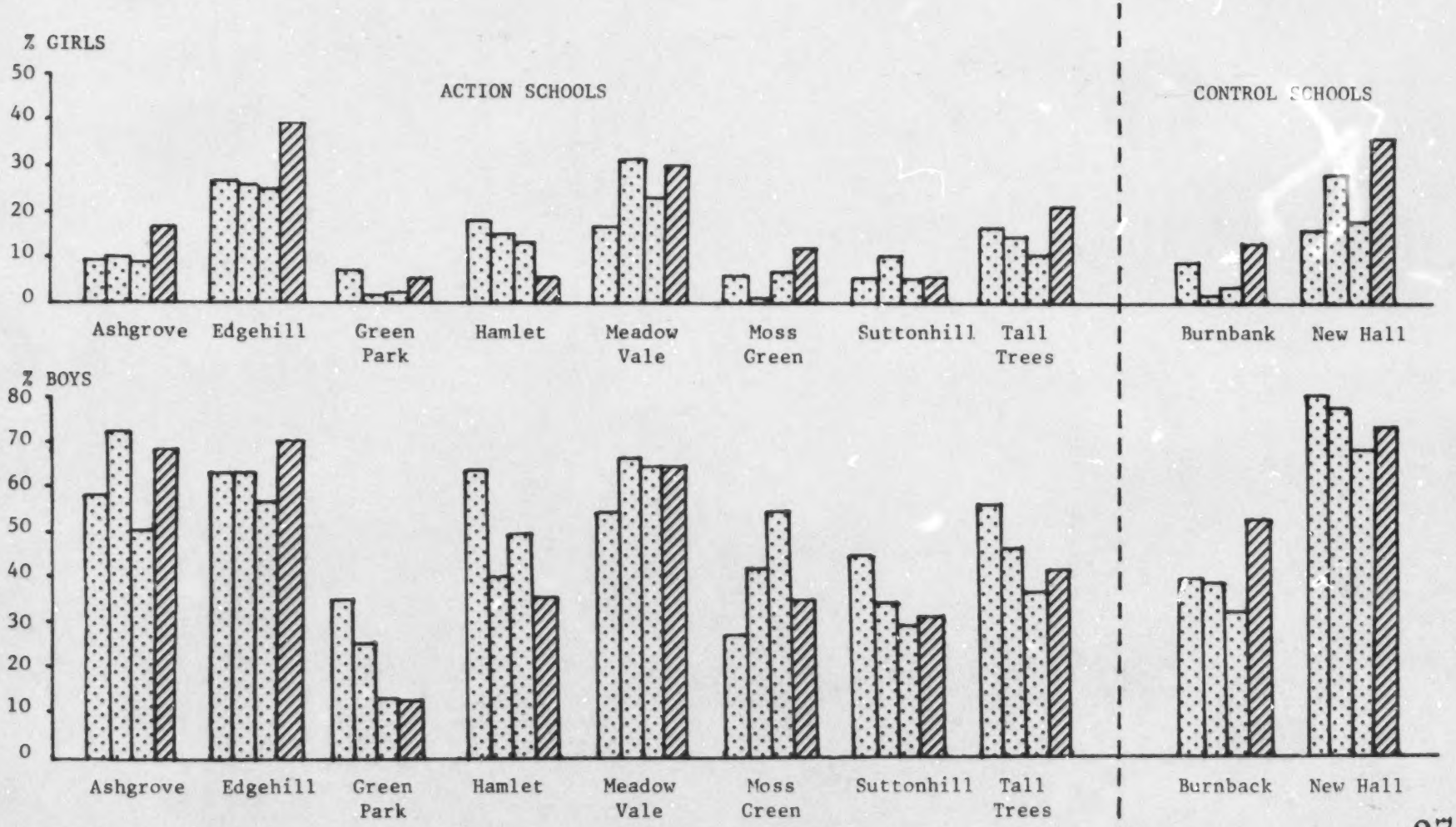
* To protect the anonymity of teachers and pupils, all school names used in this report are pseudonyms.

Figure 1: The percentage of girls and boys in the year group at GIST schools taking physics in fourth year, 1980 to 1983



previous years, 1980-1982

GIST cohort, 1983

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Figure 2: The percentage of girls and boys in the year group at GIST schools taking chemistry in fourth year, 1980 to 1983

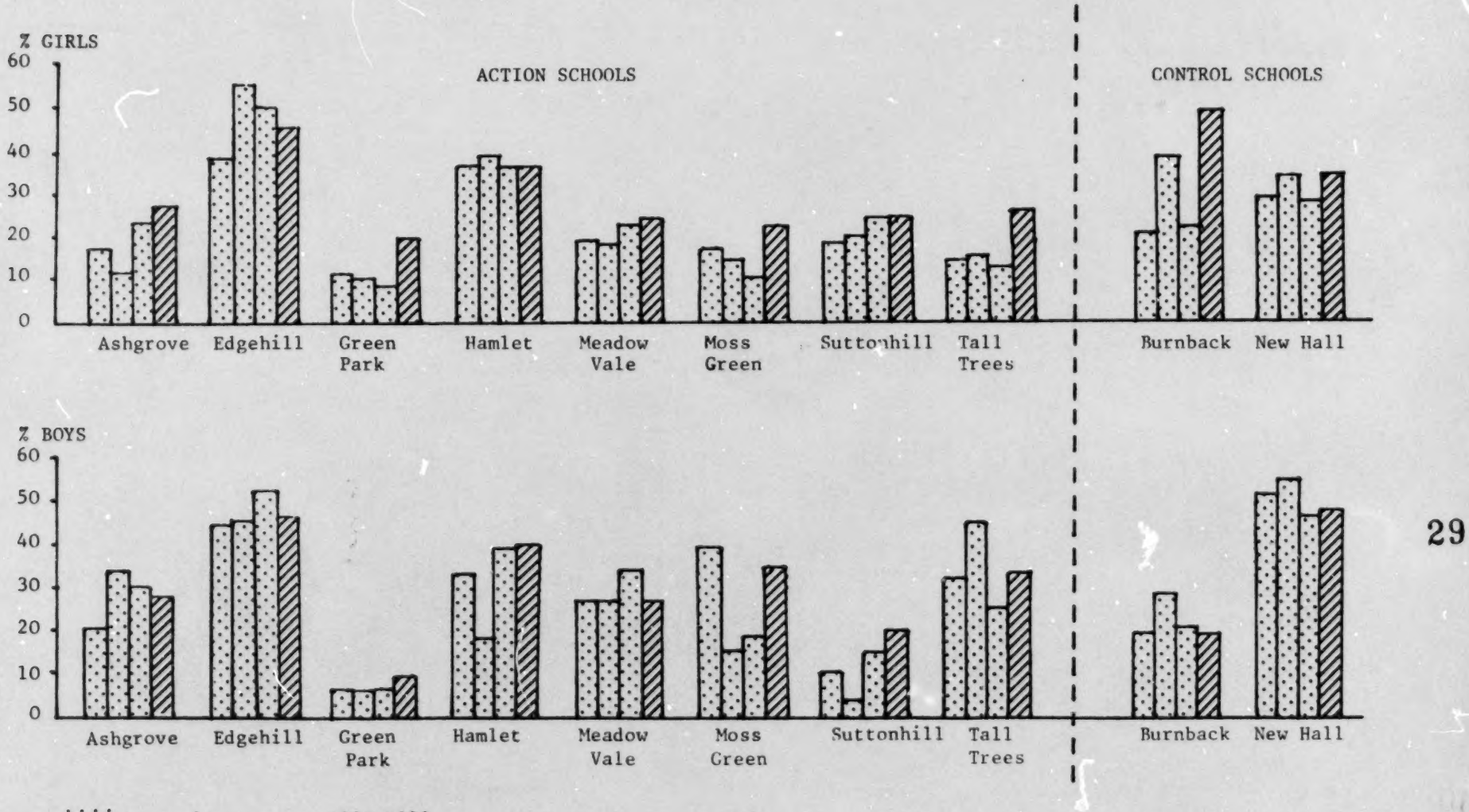

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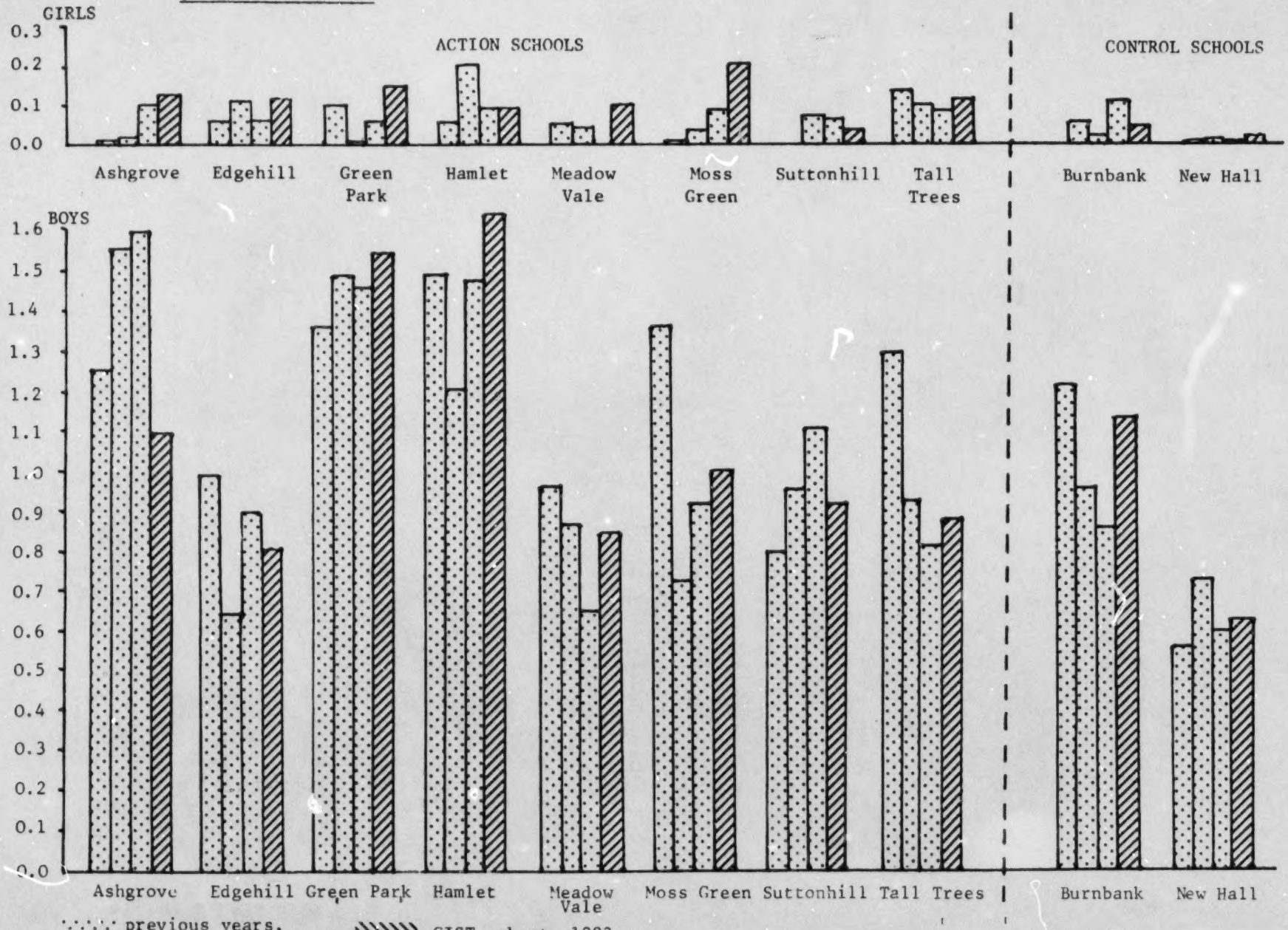
Figure 3: The average number of technical craft subjects taken by girls and boys at GIST schools in fourth year, 1980 to 1983



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school (Burnbank) had a markedly higher percentage of girls than in previous years continuing into the fourth year while in technical crafts there were slight increases in the percentage of girls in fourth year at Green Park, Meadow Vale and Moss Green. Option choice figures were also collected for biology and domestic crafts (Figures not included). These showed a marked increase in the proportion of boys at Moss Green and girls at Burnbank taking biology. At two of the action schools (Moss Green and Tall Trees) boys took slightly more domestic crafts in fourth year, while at three action schools (Ashgrove, Suttonhill and Tall Trees) and one control school (Burnbank again) girls took slightly fewer. At the other control school (New Hall) girls' uptake of domestic crafts increased from an initially low level.

To summarize then: at one action school (Moss Green) all the option choices altered in the direction the project intended, i.e., towards more girls and boys taking subjects traditionally associated with the opposite sex. At five other action schools there was at least one change in the desired direction and no negative changes. However, both control schools also fell into this category, so the changes cannot necessarily be attributed to the GIST interventions. At the remaining two action schools there were no overall changes in option choice except that fewer pupils of both sexes took physics at Hamlet.

To explain these patterns fully would require a detailed case study of each school, and this will be attempted in the GIST book (32) not here. However some points may be worth mentioning. The most successful school, in terms of changes in pupils' option choices, Moss Green, is a purpose built community school with a long term commitment to both sexual and racial equality, and a strong group of feminist teachers on the staff. GIST ideas were well supported by tutorial work in class periods. Nevertheless the general atmosphere in the school could be described as distinctly macho, and option choices in previous years were strongly sex stereotyped. It may be that GIST, as an external project, acted as a catalyst to bring about change in a school where the conditions were already favourable. The two least successful action schools, Hamlet and Suttonhill, were both re-organised during the course of the project (as were Ashgrove and Moss Green) and this may have had a disturbing effect on teachers and pupils who had more pressing concerns than GIST work.

There are three main points to bear in mind when interpreting option choices. First, it is important to remember that in the normal course of events option choices fluctuate from year to year, sometimes quite widely (see Figures 1 to 3), so it is difficult to know how much of the variation in the action year can be attributed to GIST interventions. Second, it is possible that the control schools were affected by their participation in the project so that the action/control distinction was blurred. Third, as the Figures show, there are marked differences between schools which persist from year to year.

Fluctuations in the uptake of a particular subject from year to year can have many causes. Sometimes they can be traced directly to the influence of one teacher or to policy changes within the school. In other instances the effect may be due to variations in the ability of the year group, to groups of friends deciding to do something together, or to an unusual event such as a film or visitor.

The issue of random fluctuation from year to year was explored with the heads of science and heads of physics of the two control schools, who were asked why they thought more girls (and boys in the case of Burnbank) were taking physics in the GIST cohort. Teachers at both schools initially declared themselves mystified and felt that it was a statistical fluke. On reflection they suggested that changes in the option system might have had some influence. At New Hall, physics was in a column with largely practical subjects for the GIST cohort, and at this middle class school most parents preferred their children to take academic subjects; in previous years it had been in a column with the second languages which probably siphoned off many able girls. At Burnbank there was a straight choice between physics and commerce and this had not changed. But chemistry, which was previously set against history, had been set against geography for the GIST cohort and staff felt that this would account for the increase in girls taking chemistry. Similar alterations in the option systems may have affected pupils' choices in the action schools.

GIST did not conform to a classical experimental model in that both staff and pupils in the control schools knew they were involved in an experiment, and the staff knew of its purpose. Teachers at both control schools felt that the act of filling in the questionnaires might have made the children think a bit and the teachers themselves were almost certainly affected by their involvement with the project. However they denied that they had made any greater efforts than usual to encourage girls to take physics. They also denied that their own or their colleagues behaviour had been in the least influenced by their participation in GIST. This reaction was also common among teachers in the action schools (see Section 10.1) and should perhaps not be taken at face value.

Figures 1 to 3 show that there is considerable variation between schools in the percentage of girls and boys taking each subject. For example, over 25% of all girls at Edgehill regularly took physics in fourth year, compared to under 10% at Green Park. Much of this variation can be attributed to social class. The two unambiguously middle class schools in the sample (Edgehill and New Hall) both had a high proportion of girls (and boys) studying physics. On the other hand the schools with very small proportions of girls taking physics (Green Park, Moss Green and Burnbank) were all located in working class areas. However, this is not the whole story. Individual teachers, option systems and school ethos also have some effect. Edgehill has a less affluent school population than New Hall, but a higher proportion of girls choosing physics, largely because of a faculty structure which requires most pupils to take either physics or chemisty. Meadow Vale has a mixed catchment area but a strong and effective science department with a tradition of encouraging girls. Again, this type of school by school account is pursued further in the GIST book (32).

8.2 Pupils' Attitude Changes

A range of attitude, achievement and sex stereotyping tests were administered to the GIST cohort in their first term at secondary school. A second battery of tests was given to the same pupils in the summer term of their third year (i.e., two and a half years later), as they were in the process of making their option choices. Three of the

tests - Image of Science, Science Curiosity and Occupational Stereotype - were administered on both occasions.

Children's attitudes are probably a more sensitive measure than their option choices of changes in their opinions about science, technology and sex typing. They are certainly less influenced by structural constraints such as the nature of the option system or the size of a teaching group. Changes in children's scores on the eleven subscales derived from the three tests which were administered twice are shown in Figures 4 and 5. In summary these show many significant differences between pupils' attitude changes in the action and control schools. The intervention effect appears to have been greatest on issues associated with sex stereotyping. GIST would appear to have had less impact on the general phenomenon of pupils' declining interest in science which is almost universal and not confined to girls (Gardner, 1984).

The changes in sex stereotyping are shown in Figure 4. Both girls and boys in action schools came to see much less difference in the suitability of various jobs for women and men (SEXTYPE). Children in control schools also became less stereotyped (presumably this is a maturation effect) but to a lesser extent than those in action schools.* In addition children became more enthusiastic about taking up jobs traditionally associated with the opposite sex, and this was most marked among girls in action schools (MSELF). These action/control differences are consistent with a causal effect of the children's exposure to the roadshow visits by women and men working in non-traditional jobs. Similarly the fact (Figure 5) that the difference between action and control schools was quite pronounced on SCIMALE (the extent to which science is seen as a masculine subject) and SCIENT (the image of the scientist) could be a direct effect of the VISTA visits.

As far as general attitudes to science are concerned, the action/control differences were smaller, but still significant. The data for Image of Science and Science Curiosity have been analysed in some detail (29) and they show a small but consistent trend for children in action schools to have less negative attitude changes than children in control schools (Figure 5). This was true for LIKESCI (personal liking for science), SCIWORLD (impact of science on society) and PHYSCUR (desire to learn about physical science). These scales are related to GIST interventions such as monitoring classroom interactions and promoting curriculum development, which attempted to affect the pupils' daily experience of science. It is noticeable that, contrary to the fears of some teachers, boy's attitudes were at least as positively affected as girls'. The implication is that what is good for girls in science is also good for boys.

There were also some differences between children in action and control schools on other questionnaires. Girls in action schools were

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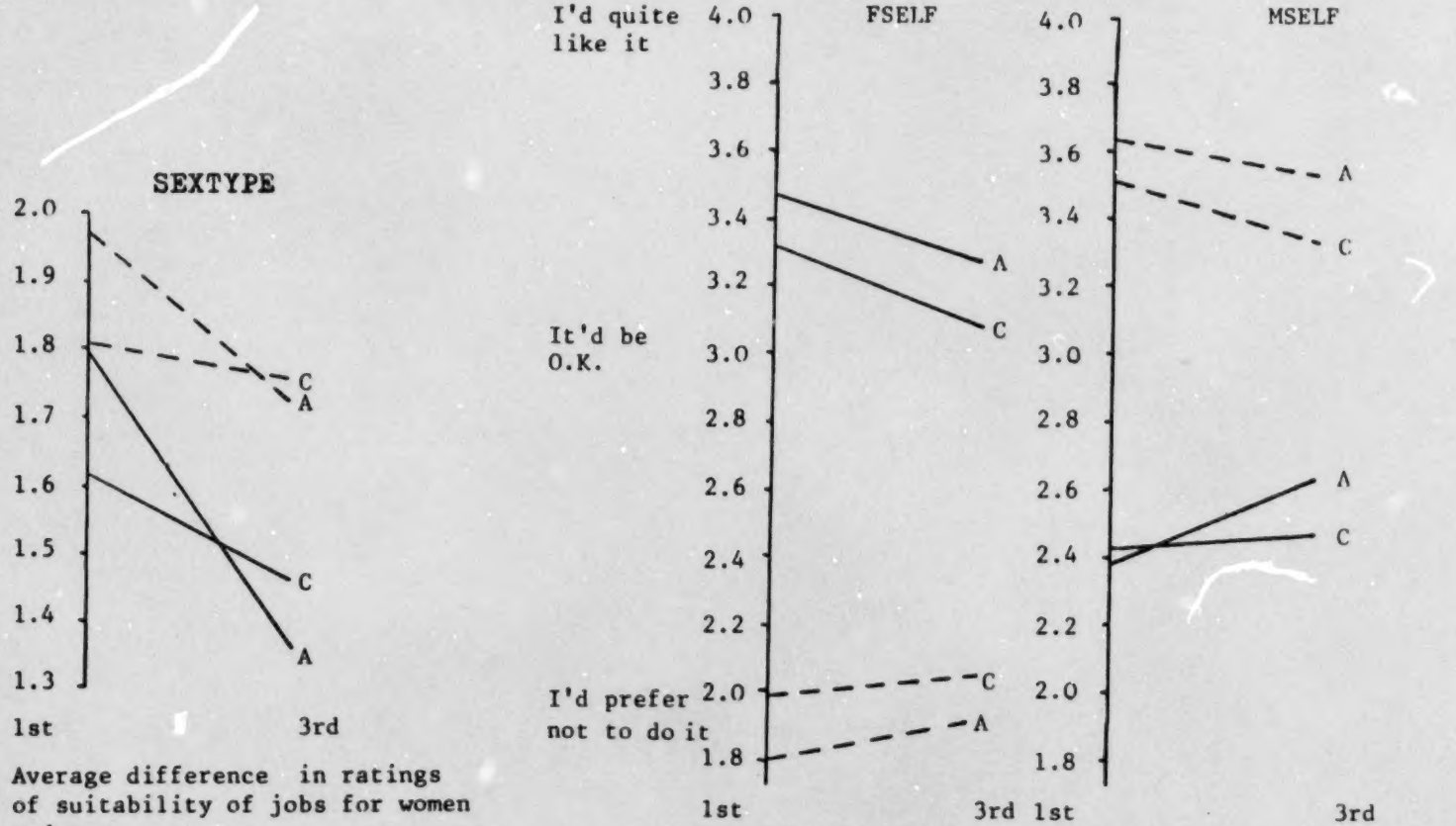
* There is no obvious reason for the large discrepancy between children in action and control schools in initial SEXTYPE scores. Matching for social class and IQ reduces the gap, but only slightly. When the data set is completely merged it will be possible to compare the changes for individual children matched on initial SEXTYPE scores.

Figure 4: The mean scores of girls of boys in action and control schools on measures of sex stereotyping in 1st and 3rd year



Average difference in ratings of suitability of jobs for women and men.

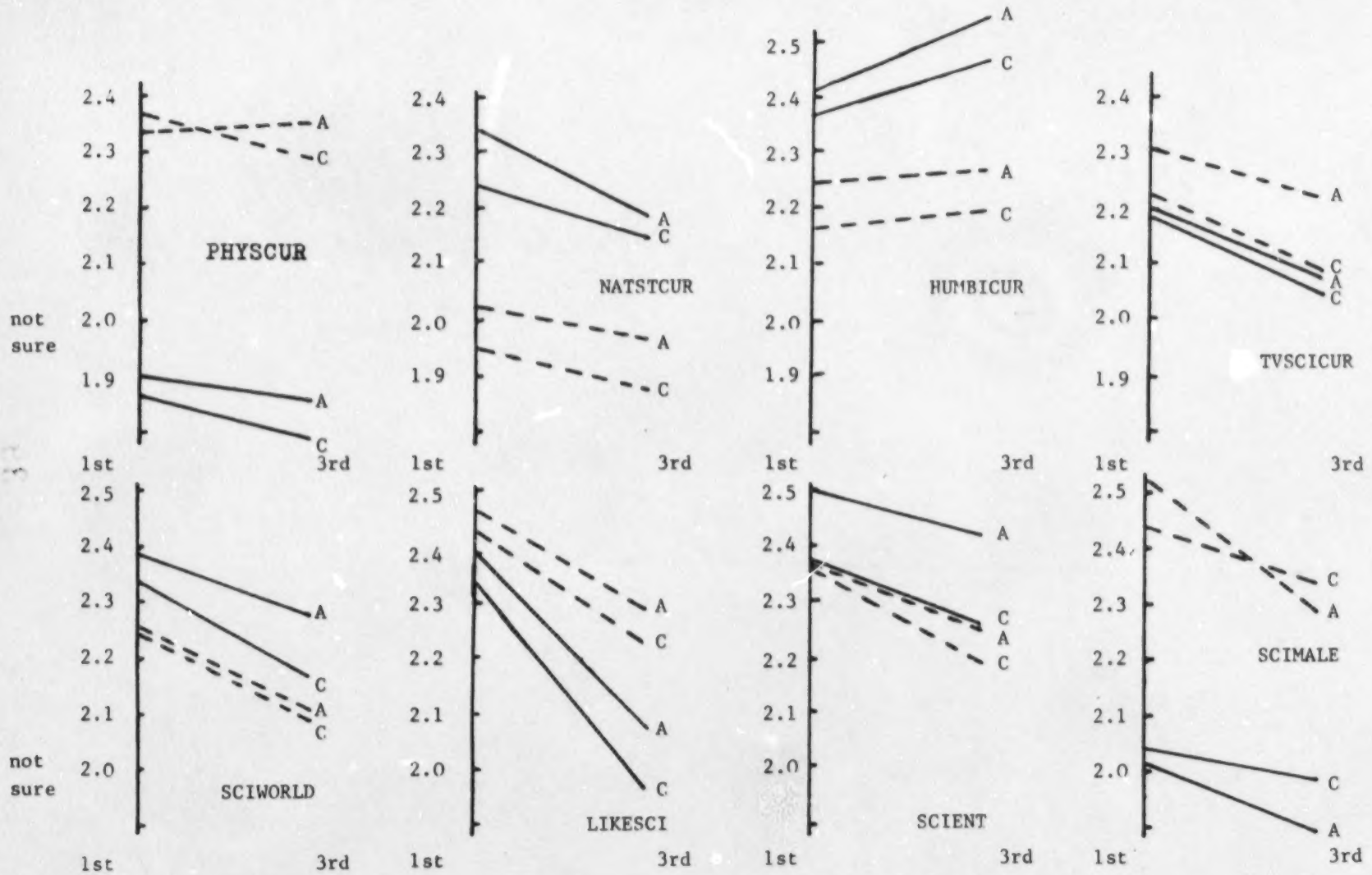
Own liking for jobs usually seen as feminine (FSELF) or masculine (MSELF).

girls — A action schools

boys - - - - C control schools

Scale from 1.0 (I'd hate it or totally unsuitable) to 5.0 (I'd like it a lot or totally suitable)

Figure 5: The mean scores of girls and boys in action and control schools on attitude to science scales in 1st and 3rd year



girls — boys - - - -

A action schools

C control schools

Scale from 1.0 (I'd like to know more or yes I agree) to 3.0 (not interested or no, I disagree)

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more likely to mention a job with some scientific or technical content as their expected or desired occupation. This is one of the most pleasing results, as it shows that the GIST project has opened up new opportunities to girls of a kind they would not have considered before. Children in action schools were significantly more likely than children in control schools to say that there were no school subjects at which one sex was better than the other. Action school girls were also more likely to want to be employed while they had young children, and less likely to say they wanted their future husband to be cleverer than themselves. On the other hand boys in the action schools were less willing to take a share in the housework if their wives were at home with children.

Attitudes did not vary as much as option choices between schools, and to save space the results are not shown separately in the Figures. However, pupils at Edgehill had consistently better attitudes in third year than would have been predicted on the basis of their first year scores. Pupils at Ashgrove and Suttonhill had consistently poor attitude changes, as did the two control schools, Burnbank and New Hall. The reasons for this variation are discussed in the GIST book (32).

9. Exploring the Sources

GIST was not only an action project but also a research project and the theoretical outcomes increase our understanding of the way in which girls' under-achievement in science and technology is constructed. This knowledge may help us to devise effective intervention strategies in the future.

9.1 First Attitude Survey

The data from the first attitude survey has now been quite thoroughly analysed and reported in a number of papers (3, 14, 15, 19, 20). The results can only be summarised here.

At age eleven girls and boys were found to be approximately equal in science knowledge. Boys did slightly better than girls on tests of physical science, especially when these were in multiple choice form, but otherwise there were few sex differences. Neither the style of the question (multiple choice or structured) nor the content (feminine or masculine) had any great effect on sex differences in performance. However boys performed markedly better than girls on tests of spatial ability and mechanical reasoning (3, 19). In one school a natural experiment occurred which suggested that spatial visualisation skills might be enhanced by experience of technical crafts. Girls and boys who, because of the way the craft circus was organised, had twelve weeks of introductory lessons in technical drawing and three dimensional work in wood and metal, increased their scores on the spatial test significantly more than a comparable group who spent the same twelve weeks on domestic crafts (15). This finding supports the theory that sex and subject specialism differences in spatial ability result, at least partly, from environmental factors and can be modified by experience. UNESCO has provided funding for a teacher to develop this work further in 1983-4.

Overall both girls and boys had positive attitudes to science when they entered secondary school, but there were some substantial sex differences (see Figure 5). Boys were much keener than girls to learn about physical science (PHYSCUR) and girls were keener than boys to learn about nature study (NATSTCUR). Both sexes were interested in human biology (HUMBICUR) and the spectacular aspects of science (TVSCICUR) . Boys had much greater experience than girls of tinkering activities but girls had more experience of biological science activities (not shown in Figures). Boys were much more likely than girls to see science as a masculine preserve (SCIMALE) and to agree with statements such as 'a woman could never be a great scientist' or 'girls don't need to know about electricity and light'. In other respects girls and boys had similar (and generally favourable) images of science and scientists. At this age attitudes to science were virtually unrelated to achievement in science and technology related areas. One important exception to this is that girls who saw science as masculine tended to perform worse on the cognitive tests (3, 20).

A number of sex stereotyping measures were included in the attitude survey, and boys were consistently found to be markedly more sex stereotyped than girls. Able girls and those from middle class homes were slightly less stereotyped than others. Mothers who did household tasks more usually undertaken by men had daughters who were less sex-stereotyped and who saw themselves as less feminine and more masculine than other girls. However, fathers' behaviour was less influential and boys were apparently unaffected. For both sexes a feminine self-image was linked to low academic achievement, and a masculine self-image to high achievement. Children who endorsed sex stereotypes showed less interest than other children in learning about the areas of science traditionally associated with the opposite sex. Thus sex stereotypes have the effect of restricting children's academic horizons even before they encounter the relevant subjects at school (14).

In a linked study, parents of GIST children at one school were studied by questionnaire and interview (6). They were asked about their educational and occupational aspirations for their children, their views on sexual equality and their children's out-of-school activities. Educational aspirations were found to be high, with little differentiation between the sexes. Parents were enthusiastic about their daughters' studying physical science, and neutral about craft subjects. Occupational aspirations were also high, and although they tended to be sex-stereotyped, parents were found to be generally supportive of non-traditional choices. Class differences were few. Most parents were in favour of working mothers, equal pay and men helping with housework. However these egalitarian attitudes co-existed with more traditional assumptions about male breadwinners and a woman's main responsibility being to her children. Parents' own household tasks, and those that they required of their children, were strongly sex-typed. The messages which children receive from their home about sex roles seem to be contradictory, but not as uniformly traditional as many teachers suppose.

9.2 Second Attitude Survey

The second survey repeated many of the attitude measures from the first survey. In addition children were asked about their experiences

of technical craft and science lessons, the influences on their option choices and their career plans. End of year test results were collected from the schools. This data has not yet been analysed in any detail.

Figure 5 shows that during the first three years of secondary schooling pupils' interest in most branches of science decreased, but both girls and boys became more interested in learning about human biology. Their opinions about science and scientists also became generally less favourable, but pupils grew more willing to see science as suitable for girls. Sex differences stayed much the same over this period and class differences were minimal. In first year science curiosity and personal liking for science were virtually unrelated to ability, but by third year there was a clear trend for more able pupils to exhibit greater interest in learning about science. This was more marked for girls than for boys (29). Individual children's attitudes were remarkably stable over the period of the study, but girls' overall liking for science came to be specifically associated with their interest in physical science

Obviously the end of year tests were different in different schools and cannot be directly compared. However on average boys in each school did slightly better than girls on the physics tests, and girls did slightly better than boys in chemistry and biology. When figures are expressed as standardised sex differences (SSD) by subtracting the girls' score from the boys' and dividing by the standard deviation, they average out at +21, -14 and -32 in physics, chemistry and biology respectively. The corresponding figures from the first year are +20 and -9 for physics and biology (there was no chemistry at this age). In other words boys had a small lead over girls in physics knowledge at age eleven and this was maintained but not increased in the third year. However girls' initial small lead in biology did increase slightly. There was insufficient information on technical crafts to make corresponding calculations in that area.

Not surprisingly pupils who opted to continue with each subject achieved much better in it than pupils who were dropping it. This was more marked in physics and chemistry than in biology. Moreover the girls who opted to continue with these two subjects performed on average slightly better than the boys (average SSD of -28 and -21 respectively). In biology there was no average achievement difference between the girls and boys who continued into fourth year. This suggests that there is a confidence barrier for girls and only the more able persist with physical science.

Sex differences in confidence were also evident when pupils were asked how they usually got on in school tests. 21% of the girls and 27% of the boys said they usually did better than most other children. When asked how they expected to get on in the future 27% of girls and a massive 41% of boys said they would do better than average. This sex difference in self-confidence did not affect attitudes to education as a whole. Girls were significantly more likely to want to go on to college or university (47% as against 30% of boys). But it did affect physical science. There was a SSD of 50 in pupils' estimates of their own performance in physics and 20 in chemistry (compared to actual performance differences of 21 and -14). For biology the self-estimates and performance were more in line with SSD of -20 and -32 respectively.

Both sexes agreed that physics was the most difficult of the three sciences and biology the easiest, although girls were more unanimous about this than boys. However the order of liking was completely different. Most girls preferred biology and disliked physics, whereas the reverse was true for boys. Again girls were more unanimous in their opinion. However the correlations between perceived difficulty, self rated ability and liking for subjects were generally low and similar for both sexes. Girls and boys had similar views on the content of lessons. Both sexes liked practical work and drawing diagrams in science and disliked writing up and dictation. In technical craft the pupils enjoyed using tools and machinery (boys more so than girls) but were less enthusiastic about marking out and discussing the results.

Girls and boys also agreed about the factors that influenced them when they chose their subjects for fourth and fifth year. For both sexes the three most important factors, all with very high ratings, were usefulness for getting a job, finding the subject interesting and their own performance in it. Parents' and teachers' opinions, the options booklet and careers talks were also rated quite important. But the opinions of friends and older pupils, who would be teaching the subject, and whether it was mainly girls or boys taking it were discounted as influences.

Focussing on the three main reasons clarifies girls' avoidance of physics and technical craft. We have already mentioned that girls thought they were doing worse than boys in physics and the same was true for technical craft with a SSD of 53. Although girls and boys largely agreed about specific features of the lessons there were very large sex differences in their ratings of physics overall as enjoyable and interesting. This was true to a lesser extent in technical crafts. Boys were also much more likely to see both subjects as useful for getting a job.

These perceptions are fairly accurate as far as the jobs that the children expected to get are concerned. Table 1 shows the five most common expected occupations for each sex. All the boys' jobs, with the possible exception of the Armed Forces, require some technical knowledge. The technical content of the girls' expected occupations is much less, although it is certainly arguable that future hairdressers, nurses and teachers would benefit from having studied science at school.

Table 1 The five most common expected occupations for girls and boys.

Girls	% mentioning	Boys	% mentioning
Hairdresser	17	Armed forces	13
Nursery nurse, something with children	15	Engineer	11
Typist, secretary	14	Something in computers	11
Nurse	11	Electrician	10
Teacher	9	Car mechanic	10

Both girls and boys were primarily concerned with having interesting, well paid work and pleasant companions in their jobs. However both pay and promotion were more important to boys than to girls, whereas helping others, meeting people and keeping clean were more important to girls than to boys. Girls scored considerably higher than boys on a scale of person orientation and were more likely to mention working with children and with animals as aspects of their ideal jobs.

Looking to the future, 22% of boys did not want their wives to go out to work, but only 4% of girls wanted to be full time housewives throughout their lives. This betokens some future marital battles! 80% of girls envisaged a career break and a return to work when the children were at school. 11% of boys but only 3% of girls thought that husbands should never help with housework. The remainder were fairly evenly split between thinking that the husband should always help and that he should only help if the the wife was employed. 27% of girls and 11% of boys wanted a spouse who was cleverer than themselves. The corresponding figures in the first survey were 34% and 6% so there has been a slight move towards more egalitarian views in this respect.

The information from different questionaires and from the two rounds of testing still has to be combined into one data set. When this has been done many other comparisons will be possible. For example, we will be able to compare the effect of the interventions on children with high and low initial scores on SEXTYPE or high and low IQ scores; we will be able to explore the relationship between attitudes to science and subject choice or career plans. The results will be reported in academic articles.

9.3 Results of Classroom Observation

Previous research (e.g. Sears & Feldman, 1974; Wernersson, 1982) has shown that on average teachers interact more with boys than with girls in the classroom. Indeed Spender (1982) suggested that 'it is almost impossible to reduce the preferential treatment of males so that teacher time and attention are distributed equally to both sexes'. This claim is not borne out by other researchers such as Wernersson (1982) and Crossman (1981), and we were sceptical about its validity. We therefore undertook to observe teachers who were consciously trying to distribute their attention in an egalitarian fashion to see if they did indeed favour boys. We were also interested in observing pupil-pupil interactions. These have seldom been investigated, but it is arguable that, particularly in laboratory-based subjects, pupils spend more time interacting with each other than they do interacting with teachers. Peers may well have a decisive influence on pupil's conceptions of subjects.

For our observation we used a very simple schedule (adapted from the Brown Interaction Analysis System (Galton, 1979)) to record the number of times the teacher interacted with girls and boys and the nature of that interaction (i.e. who initiated it, whether the purpose was disciplinary or pedagogical). We also made longhand notes on specific incidents in class. In all four different observers watched thirty four lessons. While we would certainly not claim that this is adequate for either statistical or ethnographic analysis, we did

generate some interesting hypotheses which could be more thoroughly tested in later studies.

The quantitative part of our study counted the numbers of interactions with girls and boys, rather than the time spent in these interactions, so it is not strictly comparable with earlier studies. However we found that, when they knew they were being monitored in this respect, teachers were slightly more likely to interact with girls than with boys(18). This was true of both pupil-initiated and teacher-initiated interactions. The number of observations was not sufficient to arrive at any definite conclusions, but there was a tendency for women teachers to favour girls and men teachers to favour boys.

Our more qualitative observations showed that there were marked differences in the way girls and boys behaved in class. Where resources such as apparatus were limited, boys seemed to assume that they had automatic priority. They would exercise this priority by grabbing the equipment or, if a girl got there first, by breathing down her neck until she relinquished the desired object. Boys were reluctant to wait for the teacher's attention and frequently pushed into queues or called out answers before their turn. They were much more willing than girls to take risks, both physical (with potentially dangerous apparatus) and intellectual (by guessing, often wrongly, the answers to questions) (18, 33).

MacDonald (1980) has developed the idea of 'gender codes' and argued that gender is re-contextualised within school. Thus 'the notions of appropriate behaviour for each sex (are) converted into the appropriate academic behaviour' so that some school subjects come to be seen as masculine and others as feminine. This process is dialectical - there is a 'transference of femininity....from the student to the school subject and back again to the student'. Our classroom observations provide some evidence which supports MacDonald's theoretical analysis. Boys bring with them to science lessons a conception of masculinity which includes toughness, aggression, activity and disdain for girls; girls bring with them a conception of femininity which includes insecurity, conscientiousness, deference, person orientation and a concern for appearance. These self-definitions lead girls and boys to behave in different ways, such that boys come to dominate the laboratory and learn science more successfully than girls (33). Science itself then comes to be seen as a masculine subject, success at which enhances a boys' masculinity and diminishes a girls' femininity. In other subjects - or science taught in another way - gender may be recontextualised differently.

10. Changes in Teachers and Schools

If GIST is to have any lasting impact changes need to have occurred in the teachers and schools as well as in the pupils. Only through alterations in the school ethos and in teachers' attitudes and behaviours will the innovations affect pupils in subsequent years to the GIST cohort. The extent to which such changes have taken place is assessed in this section.

10.1 Teacher's Attitudes

Most of the GIST interventions were implemented by teachers working with their own classes, and their attitudes were crucial in determining the success of these strategies. Teachers' attitudes were studied in a variety of ways. After each visit to a school we made notes on what had happened, which included comments on the teachers' responses. These notes provide a record of the way in which the commitment of individuals and departments varied during the course of the project. In the summer term of the children's third year we invited an independent team of evaluators - three male sociologists from Manchester Polytechnic School of Education - to talk to the teachers about their impression of the project and to assess the way their opinions and classroom practices had altered. This report has now been published (Payne et. al. 1984).* In addition the GIST schools were included in a student study of teachers' attitudes to educational issues which did not mention the project by name but included questions about sex differences in science and technology education (34).

Our own notes reveal considerable alterations in teachers' attitudes although these were by no means uniform. Perhaps a typical reaction from a male science teacher was for an initial scepticism to change gradually into endorsement and even enthusiasm over the first couple of years of the project's work in schools, as it became evident that GIST had practical ideas and could implement them efficiently (e.g. by organising the VISTA programme and attitude testing and producing useable curriculum materials). Although there were many exceptions we found that in general craft staff were more resistant to the aims of the project than science staff; social studies teachers on the other hand tended to be more familiar with the type of arguments we were putting forward about social pressures and inequality and they were frequently strongly supportive. The sex of the teacher seemed to make less difference than the subject they taught. Some women science teachers sympathized with the girls' problems, but others seemed to think that since they had succeeded in science there was no real problem.

The GIST initiative was not limited to changing individual teachers' attitudes, but went beyond that to an attempt to alter school norms. The extent to which we were successful in particular schools appears to have been highly dependent on the existing school ethos, and its consistency with the provision of genuine equal opportunities for girls and boys. In schools where staff felt that they enjoyed the implicit or explicit support of senior management for their efforts they were more willing to engage in activities such as open discussion with pupils about sex stereotyping. Many teachers were initially suspicious of the use of schools for 'social engineering' and unwilling to run special sessions for girls or compensate them for their relative lack of pre-scientific and practical experience by anything which smacked of 'positive discrimination'. Again, support from senior management could be crucial. One school held an in-service training day largely devoted to the 'GIST problem' and encouraged all staff to develop new ideas and approaches. Elsewhere teachers were sometimes motivated to become more

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* We regret to say that George Payne died of cancer shortly before the report was published. We are extremely grateful for his courage in continuing this work under the most difficult circumstances.

involved in GIST work by an external stimulus such as a television programme, or a newspaper article. Knowledge of GIST and sex stereotyping in general was included in senior and middle management responsibilities in one LEA so that collaboration with the project came to be seen as an asset on a curriculum vitae.

The independent evaluators were asked to talk to teachers in four action schools, in one of which we judged the project to have been successful, two fair and one unsuccessful. The evaluators were asked to explore with the teachers their perceptions of the aims of GIST and their reactions to the project, with particular attention to any changes it had effected in their opinions and behaviours. We did not arrange this until the final year of the project, so the evaluators had to rely on teachers' own accounts of their changing attitudes, rather than observing changes over time. Nevertheless we feel that it has been a valuable exercise as, for obvious reasons, teachers could talk more freely to external evaluators than to members of the project team, and the report provides independent confirmation of our own monitoring of the teachers.

With one exception all the teachers interviewed were well aware of the existence of the project and could talk for long periods about its aims and methods. The aims were generally perceived as being to do with encouraging girls in science and technical crafts and making these subjects more attractive to girls. Only four teachers (out of 34 interviewed) gave changing teachers' attitudes or behaviour as an aim, and only one mentioned changing women's position in society. As Payne et. al. (1984) comment 'the project was largely viewed as interventionist in the lives of pupils rather than the lives of teachers'. Perhaps for this reason teachers were seldom able to point to changes in their own behaviour. To quote the report again 'on balance staff seem almost grudging to concede that there have been even marginal changes in their classroom practice'. As the authors point out this may well be a defensive reaction: 'to admit to changes (perhaps to be aware of changes) in one's own practices....might be tantamount to accepting that there were inadequacies....there being inequality of treatment for half their clients'. Nevertheless many teachers described aspects of their classroom practice which can be traced directly to GIST:

> 'she always takes opportunities in her lessons to question sex stereotyping....' (p. 27)
>
> 'he has thought more about the use of extended writing' (p. 20)
>
> 'textbooks are now more closely scrutinised in terms of what activites of boys and girls are contained in them' (p. 33)
>
> 'Certainly the project has altered her teaching. She is more conscious of making efforts to involve girls. Her stress is on classroom management, teaching style, questioning strategies - she mentions trying to find more appropriate curriculum

materials.' (p. 19)

These comments are consistent with the evidence from our field notes. The evaluators' report concludes that 'some teachers **did** point to changes for themselves, that some **did** point to changes in their colleagues and that there **were** organisational changes....Given the general reluctance to refer to changes....these perceived changes stand out as important successes for the GIST project' (emphasis in original).

Overall the impression from this evaluation is of teachers who were neutral or mildly supportive towards the project, with a few cases of hostility. The hostility mainly emanated from the school where we had judged the project unsuccessful. This school was the only one in the action group to segregate the sexes for crafts at the beginning of the project. Despite the teachers' expressed feelings they had not only ceased to do this by the end of the project but had joined with another action school in a 'positive discrimination' initiative to give girls non-traditional work experience (see Section 6.2). The clash of values between the highly sex segregated atmosphere of this school and the GIST aims seemed to have been acutely felt by the teachers, of whom much greater changes of belief, attitude and practice were demanded than in any other school.

The student survey of teachers' attitudes has yet to be fully analysed (34). Preliminary results suggest that science teachers in action schools were **less** likely than their colleagues in other schools to agree that 'it is important to find ways of encouraging girls to study physical science'; this suggests that they may be more aware than teachers in other schools of the work involved in implementing school-based interventions. However teachers in action schools were also less likely to endorse naturalistic explanations of girls under-achievement in science which indicates that they are more aware than other teachers of the evidence that socialisation and sex typing affect girls' performance in science.

10.2 Changing the Climate

Our original research design allowed for two forms of evaluating success in achieving the aims of the project: the crudest was measurement of pupils' choices in the action and control schools before and after the interventions. The more refined was the measurement of pupils' attitudes to science and to sex roles at the beginning and end of the project. In 1983, we introduced another measure: the evaluation, by an independent team, of teachers' perceptions of and response to GIST. In the event, the most important effects of GIST may be virtually unmeasurable, and have certainly not been measured, as they were unanticipated. They can be described as a 'ripple' effect which the project has produced, not just in the GIST schools, or locally in Manchester, but in schools and teachers throughout the country, and even amongst an interested international audience.

The issue of girls' underachievement in science and technology is much more widely debated now than it was when GIST began. It is the subject of numerous reports, articles and discussion. Educationalists from the Secretary of State to classroom teachers have argued that encouraging girls in science should have high priority. 1984 has been

declared Women in Science and Engineering (WISE) year and events, some of which originated with GIST, are being held throughout the country. Although we would certainly not want to claim all the credit, we do feel that GIST has contributed to this changing climate. Publicity about the project appears to have reached not only science teachers but policy makers and educators generally. It has made teachers (and others) aware of the problem and shown that it is not insuperable. Our bibliography and booklets have been widely distributed and quoted and appear to have constituted an intervention in schools other than the eight directly involved in the project. Press reports and television and radio programmes have contributed to the process of making girls and science a serious educational issue.

This process will continue with the publication of three books arising from the project (30, 31, 32). The Science Sourcebook (30) will concentrate on ways to make school science more 'girl-friendly', and show how innovations designed with this goal in mind will benefit all pupils, not just girls. The CDT Sourcebook (31) combines the two main thrusts of the GIST crafts effort - towards making the craft curriculum more technologically relevant, and encouraging girls into design and technology based studies. The GIST book (32) will be interesting as an account of the first major action research project arising from the changing expectations of female roles. It draws out the main lessons of the project in relation to the single sex/mixed debate, approaches to changing teachers' attitudes and the problem of change in schools.

Part IV: Conclusions

The final part of this report provides a brief overview of the GIST project. After summarising the main results we move on to assess the outcomes. The implications of our findings for different models of change in school and in society are discussed elsewhere (32, 35).

11. Summary

Girls Into Science and Technology (GIST) was an action-research project which simultaneously took action to improve girls' achievement in science and technology and investigated the reasons for their under-achievement. The project followed a cohort of pupils in eight co-educational comprehensive schools from the time they entered secondary school until they made their option choices at the end of third year. During this time we worked with teachers in the schools to devise and implement strategies to reduce sex stereotyping, particularly as this affected girls in physical science and technical craft subjects. Two other schools were involved as controls where attitude testing but no intervention took place.

The interventions are described in Sections 4 to 7. They included a programme of visits by women working in technical jobs who talked about their work and provided role models for the girls; posters and worksheets about women's contributions to science; curriculum development to produce teaching materials more orientated towards girls interests and a humanistic view of science; observation of teachers in the classroom with feedback on how to increase girls' participation; discussions with staff and pupils about the limiting effects of sex role stereotypes; and careers advice linked to option choices in schools.

The results reported in Section 8 show that our impact on pupils' subject choices was only slight. On average approximately 4% more of the year group of girls chose physics in the GIST cohort than in previous years: in technical craft the change was even smaller. The results of the attitude testing were more encouraging. There was a small but consistent trend for children in action schools to show more positive (or to be accurate, less negative) attitude changes than children in control schools. This was particularly striking on measures of sex stereotyping where children in action schools became markedly more egalitarian.

Research results (Section 9) show that girls and boys had almost equal science knowledge when they entered secondary school. However their attitudes were already sharply divergent, with girls being interested in biological topics and boys in physical science. At the end of third year boys got slightly better marks than girls in physics; but boys' estimation of their own achievement was **much** better than girls'. Both girls and boys considered physics the most difficult science, but boys were much more likely than girls to see it as useful for their careers and to choose it for that reason.

Both at eleven and at fourteen boys were more sex sterotyped than girls. They had more definite ideas about what girls should do and what boys should do. In particular boys were more likely than girls to agree

with statements such as 'a woman could never be a great scientist' and 'girls don't need to know about electricity and light'. These attitudes were reflected in their behaviour in the laboratory and workshop where boys tended to monopolise the equipment and taunt girls who made mistakes. 21% of boys said they did not want their wives to be employed, but only 4% of girls wanted to be permanent housewives.

Most of the action strategies were implemented by teachers, and their attitudes were crucial. Evaluation (Section 10) suggested that most teachers were supportive of GIST in a general sense, but did not feel that their own practice had altered much as a result of the project. However there was some evidence of change in their behaviour, and those who recieved institutional support for innovation were in the best position to respond actively. Perhaps the greatest impact of the project was a ripple effect whereby interest in GIST contributed to a changing climate of opinion in which girls' under-achievement in science and technology came to be seen as a serious educational issue. In this climate concerned teachers are seeking ways to alleviate the problem in their own classrooms, and GIST can help with explanations, suggestions and materials.

12. Assessment

Hunkins (1980) has argued that there are four levels of difficulty in bringing about educational change. The easiest step is to advance our knowledge of the situation. Next comes the changing of attitudes followed by changes in the behaviour of individuals. Finally there is change in the institutional ethos. Applying this model to GIST we would argue that the project has considerably increased our knowledge about girls' under-achievement in science and technology and the reasons for this under-achievement. It has had some effect on children's attitudes (particularly with respect to sex stereotypes and what they consider is acceptable for girls and boys to do). However there has been less impact on children's behaviour when making their option choices. Teachers' attitudes are usually longer established than children's and their world-views are less fluid. Thus it is logical that the institutional ethos, as the collective manifestation of these world views, should be most impervious to change; and so it proved to be in this project.

GIST has been successful in that it has refined our understanding of girls' and boys' attitudes and stereotypes about science, and the process of option choices. The specific focus of interventions was the stereotyping of science and technology as masculine, and in this respect the children's attitudes were considerably modified. Children's option choices (a behavioural phenomenon) are strongly affected by their daily experience of school subjects, and this was less susceptible to GIST interventions. Some teachers' attitudes, no less than their behaviour, altered in the desired direction. Finally, there is evidence that changes in group behaviour were more likely to occur in schools and departments where the prevailing ethos comfortably incorporated GIST concerns.

The results of the GIST project might be something of a disappointment to anyone who thought that schools alone could solve the problem of girls' under-achievement in science and technology. But of

course schools cannot act alone; they are enmeshed in the wider social structure. Parents, primary schools, peers and employers all influence children's attitudes and their choices. Teachers are reluctant to change their routines, and men as a group have no wish to relinquish their power. Against these odds it is perhaps more surprising that GIST had any impact at all than that its impact was limited.

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